

Claims

1. In combination, a closed loop optical fiber for carrying information modulated on at least two optical carriers, a first one of the carriers having a first wavelength and a second one of the carriers having a second wavelength, at least two nodes at a first one of which first information modulated on the first carrier and second information modulated on the second carrier is to be recovered and transmitted, the first node comprising a first demultiplexer for demultiplexing the first carrier from the fiber, a second demultiplexer for demultiplexing the second carrier from the fiber, a first multiplexer for multiplexing the first carrier on the fiber, a second multiplexer for multiplexing the second carrier on the fiber, and apparatus for receiving and transmitting first and second information, the apparatus for receiving and transmitting first and second information consisting essentially of a first receiver for demodulating first information and a first transmitter for modulating first information on the first carrier before the first carrier is placed on the fiber by the first multiplexer, a second receiver for demodulating second information and a second transmitter for modulating second information on the second carrier before the second carrier is placed on the fiber by the second multiplexer.

2. The apparatus of claim 1 further comprising first and second switches, each of the first and second switches having first and second input ports and first and second output ports, each of the first and second switches having first and second states, the first state of each of the first and second switches coupling the respective first and second switch's first input port to its first output port and its second input port to its second output port, the second state of each of the first and second switches coupling the respective first and second switch's first input port to its second output port and its second input port to its first output port, the first receiver coupled to the first input port of the first switch, the second receiver coupled to the second input port of the first switch, the second output port of the first switch being coupled to the second input port of the second switch, the first output port of the second switch being coupled to the first transmitter, the second output port of the second switch being coupled to the second transmitter, the node controlling the first and second switches so that when the first carrier is not capable of transmitting first

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information over the fiber, the first information is modulated on the second carrier for transmission over the fiber.

3. The apparatus of claim 2 further comprising a third optical carrier having a third wavelength, the first demultiplexer also removing the third carrier from the fiber, the first multiplexer also placing the third carrier on the fiber, and apparatus for receiving and transmitting third information, the apparatus for receiving and transmitting third information consisting essentially of a third receiver for demodulating third information from the third carrier and a third transmitter for modulating third information on the third carrier before the third carrier is placed on the fiber by the first multiplexer, the fiber coupling the third carrier to the first demultiplexer and the first multiplexer coupling the third carrier to the fiber.

4. The apparatus of claim 3 wherein each of the first and second switches has first, second and third input ports and first, second and third output ports, each of the first and second switches having first, second, third and fourth states, the first state of each of the first and second switches coupling its first input port to its first output port, its second input port to its second output port, and its third input port to its third output port, the second state of each of the first and second switches coupling its first input port to its second output port, its second input port to its first output port and its third input port to its third output port, the third state of each of the first and second switches coupling its first input port to its first output port, its second input port to its third output port, and its third input port to its second output port, and the fourth state of each of the first and second switches coupling its first input port to its third output port, its third input port to its first output port, and its second input port to its second output port, the first receiver being coupled to the first input port of the first switch, the second receiver being coupled to the second input port of the first switch and the third receiver being coupled to the third input port of the first switch, the third output port of the first switch being coupled to the third input port of the second switch, the node controlling the first and second switches so that when one of the first and third carriers is not capable of transmitting a respective one of first and third information over the fiber, the respective one of first and third information is modulated on the second carrier for transmission over the fiber.

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5. The apparatus of claim 4 further comprising a fourth optical carrier having a fourth wavelength, the fiber coupling the fourth optical carrier through at least one of the first and second demultiplexers and through at least one of the first and second multiplexers so that the fourth optical carrier passes through the first node
5 unaffected.

6. The apparatus of claim 5 wherein the fiber couples the fourth optical carrier through the first and second demultiplexers and through the first and second multiplexers.

7. The apparatus of claim 1 further comprising a third optical
10 carrier having a third wavelength, the fiber coupling the third optical carrier through at least one of the first and second demultiplexers and through at least one of the first and second multiplexers so that the third optical carrier passes through the first node unaffected.

8. The apparatus of claim 7 wherein the fiber couples the third
15 optical carrier through both of the first and second demultiplexers and through both of the first and second multiplexers so that the third optical carrier passes through the first node unaffected.

9. In combination, first and second loops of optical fiber for carrying information modulated on a first optical carrier, the first carrier having a first
20 wavelength, at least two nodes at a first one of which first information modulated on the first carrier is to be received and transmitted, the first node comprising a first demultiplexer for demultiplexing the first carrier from the first fiber, a first multiplexer for multiplexing the first carrier on the first fiber, and apparatus coupled to the first demultiplexer for receiving, and to the first multiplexer for transmitting, first
25 information, first and second switches, each of the first and second switches having first and second input ports and first and second output ports, each of the first and second switches having first and second states, the first state of each of the first and second switches coupling the respective switch's first input port to its first output port and its second input port to its second output port, the second state of each of the first
30 and second switches coupling the respective switch's first input port to its second output port and its second input port to its first output port, the first optical fiber coupled to the first input port of the first switch and to the first output port of the

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second switch, the second optical fiber coupled to the second input port of the first switch and to the second output port of the second switch, the first output port of the first switch coupled to the first demultiplexer, the first multiplexer coupled to the first input port of the second switch, and the second output port of the first switch coupled to the second input port of the second switch.

10. The apparatus of claim 9 further comprising a second optical carrier transmitted along the second optical fiber in a second direction opposite to the first direction, the second carrier having a second wavelength λC .

11. The apparatus of claim 10 further comprising a third optical carrier, second information modulated on the third carrier, the third carrier transmitted along the first optical fiber in the first direction.

12. The apparatus of claim 11 wherein the first demultiplexer demultiplexes the third carrier from the first fiber, the first multiplexer multiplexes the third carrier on the first fiber, and further comprising apparatus coupled to the first demultiplexer for receiving, and to the first multiplexer for transmitting, second information.

13. The apparatus of claim 9 wherein the first node controls the first and second switches so that when one of the first and second optical carriers is incapable of being transmitted along its respective fiber in its respective direction, one of the first and second switches is switched from its first state to its second state so that the respective optical carrier is transmitted in the opposite direction on the other of the first and second fibers.

14. The apparatus of claim 9 further comprising a second optical carrier, second information modulated on the second carrier, the second carrier transmitted along the first optical fiber in the first direction.

15. The apparatus of claim 14 wherein the first demultiplexer demultiplexes the second carrier from the first fiber, the first multiplexer multiplexes the second carrier on the first fiber, and further comprising apparatus coupled to the first demultiplexer for receiving, and to the first multiplexer for transmitting, second information.

16. In combination, first and second closed loop optical fibers for carrying information modulated on a first optical carrier, the first carrier having a first

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wavelength, at least two nodes at a first one of which first information modulated on the first carrier is to be received and transmitted, the first node comprising a first demultiplexer for demultiplexing the first carrier from the first fiber, a first multiplexer for multiplexing the first carrier on the first fiber, a second demultiplexer for demultiplexing the first carrier from the second fiber, a second multiplexer for multiplexing the first carrier on the second fiber, first apparatus coupled to the first demultiplexer for receiving, and to the first multiplexer for transmitting, first information, first and second switches, each of the first and second switches having first and second input ports and first and second output ports, each of the first and second switches having first and second states, the first state of each of the first and second switches coupling the respective switch's first input port to its first output port and its second input port to its second output port, the second state of each of the first and second switches coupling the respective switch's first input port to its second output port and its second input port to its first output port, the first optical fiber coupled to the first demultiplexer, the first demultiplexer coupled to the first input port of the first switch, the second demultiplexer coupled to the second input port of the first switch, the first output port of the first switch coupled to the first receiving apparatus, the first transmitting apparatus coupled to the first input port of the second switch, the second output port of the first switch coupled to the second input port of the second switch, the first output port of the second switch coupled to the first multiplexer, and the second output port of the second switch coupled to the second multiplexer.

17. The apparatus of claim 16 wherein the first node controls the first and second switches so that when the first optical carrier is incapable of being transmitted along the first fiber in the first direction, one of the first and second switches is switched from its first state to its second state so that the first optical carrier is transmitted in the second direction on the second fiber.

18. The apparatus of claim 16 further comprising a second optical carrier, second information modulated on the second carrier, the second carrier transmitted along the first optical fiber in the first direction.

19. The apparatus of claim 18 wherein the first and second demultiplexers are each capable of demultiplexing the first carrier and the second

carrier, and further comprising second apparatus for receiving and transmitting the second carrier, the second apparatus coupled to the first and second demultiplexers for receiving, and to the first and second multiplexers for transmitting, the second information.

5 20. The apparatus of claim 19 and further comprising third and fourth switches, each of the third and fourth switches having first and second input ports and first and second output ports, each of the third and fourth switches having first and second states, the first state of each of the third and fourth switches coupling the respective switch's first input port to its first output port and its second input port to its second output port, the second state of each of the third and fourth switches coupling the respective switch's first input port to its second output port and its second input port to its first output port, the first optical fiber coupled to the first demultiplexer, the first demultiplexer coupled to the first input port of the third switch, the second demultiplexer coupled to the second input port of the third switch, the first 10 output port of the third switch coupled to the second receiving apparatus, the second transmitting apparatus coupled to the first input port of the fourth switch, the second output port of the third switch coupled to the second input port of the fourth switch, the first output port of the fourth switch coupled to the first multiplexer, and the second output port of the fourth switch coupled to the second multiplexer.

15 21. The apparatus of claim 20 wherein the first node controls the third and fourth switches so that when the second optical carrier is incapable of being transmitted along the first fiber in the first direction, one of the third and fourth switches is switched from its first state to its second state so that the second optical carrier is transmitted in the second direction on the second fiber.

20 22. The apparatus of claim 16 further comprising a second optical carrier transmitted along the second optical fiber in a second direction opposite to the first direction, the second carrier having a second wavelength λC .

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